MEMORANDUM

TO: BDCP Steering Committee, via Karen Scarborough

FROM: BDCP Facilitation Team (Wayne Spencer, Bruce DiGennaro)

DATE: July 11, 2007

RE: Early Input of BDCP Lead Scientist Concerning Evaluation of Conservation Strategy Options

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The attached document provides early advice from the BDCP Lead Scientist (Dr. Denise Reed) on methods and approaches for evaluating BDCP Conservation Strategy Options. The document was prepared by Dr. Reed at the request of the BDCP Steering Committee. The observations and recommendations provided in the attached document represent the opinions of the Lead Scientist based on discussions with the SAIC Team and her relevant experience with other similar planning studies.

The primary purpose of the attached document is to provide early advice to the SAIC Team and the Steering Committee regarding current efforts to evaluate four Conservation Strategy Options for water conveyance. However, many of the observations and recommendations provided in the attached document are also applicable to future evaluations of the selected Conservation Strategy Framework, even if they cannot be applied during this initial evaluation phase due to schedule or other constraints.

The attached observations and recommendations are provided with the understanding that the evaluation of Conservation Strategy Options currently being undertaken by the SAIC Team is by nature limited in function and scope. It is our understanding that a more comprehensive analytical approach will be applied at a later date once a Conservation Strategy Framework is selected. We further understand that the primary goal of the current evaluation is to assess which conveyance option appears to offer the best opportunity to help contribute to meeting plan objectives for purposes of carrying it forwarded to the plan development process later this year and into 2008.

In the capacity of neutral intermediary, the Facilitation Team is transmitting the attached material to the BDCP Steering Committee for their use. The Facilitation Team has reviewed the document for clarity and presentation, but has not made any modifications to the technical content of the document.

Any comments, corrections regarding the factual content of the attached document, or clarifying questions should be directed to the Facilitation Team. As needed, we will work with the Lead Scientist to correct any factual errors or misrepresentation and provide a final document.

Bay-Delta Conservation Plan
Early Input of Lead Scientist
Advice on Evaluation of Conservation Strategy Options
10 July 2007

1.0 Introduction

The objective of this memo is to provide the Steering Committee with some comments on the proposed approach for the evaluation of conservation strategy options. Incorporation of these recommendations is not intended to require any additional analysis beyond that currently planned, and with some engagement by the Steering Committee or their workgroups, it is not expected that they would delay the current work plan.

This memo has been developed on the basis of:

- The experience of the lead scientist with evaluation methodologies for water resource planning[i]
- The lead scientist's recent experience in developing assessment methods to assist the State of Louisiana in the development of its recent Master Plan for Coastal Protection and Restoration[ii]
- Brief surveys of existing literature (published and unpublished) on decision-making approaches (specific sources cited later as appropriate)
- Discussions with the SAIC planning team (6/29/07 and 7/6/07) to obtain a better understanding of the approaches used in the evaluation of conservation element bundles and more detail on their proposed method for evaluating conservation strategy options.

Dr. Reed consulted with Mr. Adam Hosking of Halcrow, with whom she worked on the Louisiana Master Plan process, and he assisted with the identification of additional background documents on methods used in UK shoreline management planning.

2.0 General Comments

The process for the evaluation of conservation strategy options currently being undertaken for the BDCP will be largely qualitative in its approach. This is a result of the time available for evaluation and the coarse descriptions of the conveyance strategies being evaluated. However, even given the limited scope and function of this evaluation, the transparency and 'auditability' of the evaluation methodology can be improved by using a more rigorous structure to the qualitative evaluation and by effectively incorporating quantitative evaluations with the largely qualitative approach.

3.0 Rationale for Evaluations

The tight timeline for the current planning process requires that it is largely qualitative and based on expert opinion. One of the main deficiencies of the Species Stressor Tables[iii] and the evaluation of the conservation element bundles was the lack of citations or other indication of the sources of information behind the narrative or tables. This omission reduces the credibility of the evaluation. It is essential that this issue is addressed in the current evaluation process. The use of citations can reduce the length of the narrative, and indicate the depth of available knowledge. Citations could include a range of sources, from the scholarly literature, to agency

data reports, to presentations at meetings. Recognizing that there may be some issues which cannot be supported by citations, then the source of the expert knowledge should be identified as personal communication. If no individuals are considered expert sources, and the evaluation is based on a group consensus, the group should be identified in the text and participants listed in front or end matter.

Recommendation: *The source of information used in the evaluation must be referenced.*

4.0 Moving from Stressors to Outcomes

The evaluation of conservation element bundles included an assessment of each potential stressor and its impact on key life history stages of the covered species. The stressors were used to identify potential conservation measures, and in the evaluation of conservation element bundles. For Splittail the stressors were also allocated to four categories according to the presumed importance of the stressors. The large lists of initial stressors, while representing a comprehensive view of potential problems, present challenges in the forthcoming evaluation process, specifically:

- Interactions among stressors are not presently considered
- All stressors are considered equal in the stressor tables
- The level of information to support some of the stressor evaluations is likely minimal

The biological evaluation criteria represent the outcomes desired by the plan. The evaluation of the four conservation strategy options must focus on their ability to achieve the outcomes – thus linkages between important stressors, or groups of stressors and the plan's desired conservation outcomes need to be clearer.

Recommendation**:** *The ranking procedure for stressors conducted for Splittail should be conducted for all species currently being considered, and important interactions among stressors identified. This ranking should be based on clearly identified criteria for ranking, with adequate citations back to the underlying scientific information used to support the rankings.*

5.0 Assessing the Performance of Strategies against Criteria

5.1 Identifying Benchmarks or Baselines for Comparison. The current phrasing of the evaluation criteria calls for the assessment of strategies relative to one another. Relying entirely on relative assessment is problematic as, even at this early stage in the process, decision-makers need to know something about the magnitude of the outcomes. Many other planning processes compare performance relative to a baseline, benchmark, or target. The Corps of Engineers planning process for water resource projects (under the WRC Principles and Guidelines[iv]) evaluates alternative plans against a no-action alternative. The inclusion of benchmarks for protection and targets for restoration Louisiana Master Plan in 2006[v] provided stakeholders with a clearer indication of potential outcomes than previous planning efforts based on very general goals[vi]. The multi-criteria analysis (MCA) for the flood and coastal management planning in the UK uses a baseline assessment of future impacts against which to assess management options[vii].

Importantly, this type of benchmarking does not require the identification of quantitative targets.

Recommendation: *The SAIC team should consider developing benchmarks for the achievement of the biological objectives against which the performance of strategies can be compared. These could be developed by a group of experts and should be general in nature.*

5.2 Scaling of Outcomes Relative to Benchmarks/Baselines. A number of procedures have been used to scale the outcomes of various planning options. Where a binary evaluation is appropriate (e.g., an outcome either meets or fails to meet an evaluation criterion) the concept of percentage compliance could be used[viii]. This enables decision makers to identify the degree to which conservation options meet or fail to meet biological or other program objectives. Given that BDCP evaluation requires more of a relative assessment of each option's performance relative to the criteria, other more 'scalable' approaches may be appropriate. Some examples are outlined below.

a. The range of potential biological responses for each criterion (by species as appropriate) can be scaled from desirable (e.g., a ++ rating) to undesirable (e.g., a -- rating). This approach was used to assess the performance of options for protection and restoration in coastal Louisiana[ix]. It requires the identification of metrics to assess the performance of options, but as it is a categorical approach, it could be applied as part of a qualitative assessment (provided that the justification for the assignment of categories is sufficiently tracked) or one that is informed, but not driven, by data or model output.
b. An alternative but well recognized approach is to scale the performance of the options relative to the one with the most positive outcome. The best performing option for a particular category of assessment is set at 100 and the response of other options is scaled relative to that score (e.g., a response which is half as beneficial scores a 50, one that is an order of magnitude lower scores a 10, etc).[x]. The advantage of the 100 point scale is that it allows a wide range of possible responses (over two orders of magnitude) to be scaled relative to one another. The assignment of scores is based on technical assessments rather than preferences (i.e., this is a scoring rather than a weighting procedure) and the justification for the scoring must be recorded.
c. The evaluation of the bundles of conservation elements included a coarse assessment of the population level benefits. That evaluation process provided a very generalized approach to assessing biological responses (e.g. low, medium and high population level effect). The planning team for the Delta Regional Ecosystem Restoration Implementation Plan (DRERIP) has developed a categorical approach for scaling the magnitude of ecological outcomes, which may be of value to the BDCP evaluation process. The latest draft of this scaling approach is provided as Attachment A for illustrative purposes. Such a scaled approach could be useful for assessing the performance of an option relative to an individual evaluation criterion or could be used as part of an overall assessment.

Recommendation**:** *The SAIC team should consider these and other approaches for scaling the biological responses for the evaluation criteria, and identify and apply a process for scaling responses either relative to one another or relative to a benchmark. This will provide the Steering Committee with a more rigorously scaled indication of the relative performance of the conservation options to the evaluation criteria.*

6.0 Assessing the Overall Performance of the Strategies

The performance of each option against each criterion can be scaled in the manner suggested above. However, there still remains the issue of how to summarize the overall performance of each option, either across all criteria or for each group of criteria (e.g., Biological, Planning, etc). This is especially challenging as evaluations for some of the criteria will likely be quantitative (e.g., criterion #8) and others will be qualitative.

A range of planning tools are available to conduct such evaluations, many of which provide for direct input from stakeholders regarding weighting and/or provide a framework for considering uncertainty more explicitly. For example, multi-criteria analysis provides a framework for simultaneously considering multiple, often conflicting objectives. It is a widely used technique that can incorporate a wide range of information formats[xi]. The Delphi Survey Method uses anonymity to minimize bias while systematically developing a consensus opinion among experts[xii]. Robust Decisionmaking seeks to inform decision making under conditions of deep uncertainty by providing a formal framework, using an iterative, quantitative process that allows decision makers to identify strategies that perform well despite uncertainty surrounding key issues[xiii].

Given the time available for the current evaluation of the four options, it is unlikely that any of these more formal approaches can be implemented at this time, but these and other analytical approaches may be suitable for later in the planning process when the overall conservation plan has matured in scope and level of detail. However, once the four options have been evaluated against each of the criteria, the results can be presented in a format that allows ready comparison of option performance. Ranking the options for each criterion or grouping according to performance and presenting the results in a comparative table could be a simple way of providing an overall assessment[xiv]. This allows both quantitative and qualitative evaluations for the individual criteria to be combined.

Recommendation**:** *The SAIC team should consider a using a performance ranking approach to summarize the results of their evaluation, in addition to the tabular presentations of evaluation previously used. The Steering Committee should consider using one of the more formal approaches to evaluation for subsequent phases of plan development. The planned workshop of independent science advisors on methods of analysis will provide more detailed recommendations.*

7.0 Acknowledging Uncertainties and Variability

It is not necessary at this time to quantify the uncertainty surrounding the biological responses to the conservation options, but some consideration of the impacts of uncertainty on scoring or response assessment would increase the credibility of the assessment. This must be considered in the use of both quantitative and qualitative assessments:

7.1 Variability. Consideration of variability is particularly important for outputs of the coarse modeling that will inform the evaluation. CALSIM and DSM2 will be used by the planning team to assess the relative ability of the options to meet some of the evaluative criteria. This modeling will produce outputs that reflect the potential response of select flow-related parameters (e.g., the position of X_2) to conservation options across the range of water-year types (e.g., wet, above normal, below normal, dry, and critically dry). However, the 72-year historical record which forms the basis of CALSIM runs will produce results for a number of years, and for months within those years, in each category. This allows for quantifying the variation in system response even within a given water-year type, thus allowing a more informed assessment of the differences among options.

Recommendation**:** *The SAIC team should present the results of the coarse modeling in a format (e.g., bar charts with error bars) which allows both direct comparison of the options and consideration of the variability in hydrologic response of each option to specific flow scenarios.*

7.2 Level of Understanding. The more qualitative assessment of biological response to conservation options will be based on existing knowledge and expert opinion. As already recommended it is crucial that the SAIC team track the sources of information used in their assessments and evaluate the level of understanding reflected in the sources thus referenced. It is also important to acknowledge the variability in ecosystem processes which may constrain the prediction of biological responses to any particular action. The DRERIP planning team has developed an approach to scaling the relative certainty of outcomes (or biological responses) to conservation actions. This approach incorporates both the level of scientific understanding of the inferred process-response and the effect of ecosystem variability on outcomes. A draft of the scoring approach is provided in Attachment A.

Recommendation**:** *The Planning Team should consider a scaled approach to assessing the certainty of biological responses and consider using the DRERIP approach, which assigns categories of certainty based upon scientific understanding and variability of ecosystem processes.*

8.0 Presenting Information

The wealth of information on some of the issues encompassed by the evaluation, combined with the need to clarify sources of information and justify scaling of responses against criteria, presents a real challenge to the SAIC team in terms of presentation. The need to be clear, concise and thorough can be met by using structured tables with fields used to justify scoring,

insert citations, and consider uncertainties while providing for additional comments as necessary. This approach will ensure a similar level of consideration is given to each criterion within a group and allow the user to readily access information. Appraisal Summary Tables have been used in the UK to structure information and facilitate assessment of policy options for flood management and coastal defense in the UK[xv]

The use of diagrams and visual scaling approaches will greatly assist the Steering Committee as they consider the results of the evaluation. For example, radial line plots allow the relative performance of options across a number of criteria to be shown easily. They have been recommended for use in coastal engineering evaluations[xvi], and have been used in the Louisiana Master Planning Process[xvii] and in restoration planning for South San Francisco Bay Salt Ponds[xviii]. Potentially negative outcomes associated with the conservation options will also be evaluated. Traditional red-yellow-green 'stop-light' color schemes can be very effective in highlighting the relative importance of both positive and negative responses.

> Recommendation: *The SAIC team should consider the most effective way to communicate the results of their evaluation of conservation strategies to ensure easy access to information and objective and even-handed comparison across criteria using appropriate visualization methods.*

Notes

[i] Dr Reed was a member of an NRC committee which reviewed the Corps if Engineers methods of analysis [Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning. Panel on Methods and Techniques of Project Analysis. 2004. Analytical Methods and Approaches for Water Resources Project Planning. Water Science and Technology Board, National Academy of Sciences, Washington DC. 151 pp.], and has prepared summaries of benefits evaluation approaches for the State of Louisiana and the Corps of Engineers (Reed, D.J., K. Orth, J. Smyth and R. Caffey. 2005. Concepts for Future Decision Making and Benefits Analysis for Louisiana Coastal Restoration. Chapter 8 in CLEAR Volume III found at http://www.clear.lsu.edu/clear/web-content/Web_items/Vol_III_Report/Vol_III_Chpt08.pdf).

[ii] Appendix xx of Master Plan citation describes the approach for evaluating alternative plans developed by Dr. Reed and other consultants to the Master Plan development process.

[iii] Species Stressor Tables provided in 'Summary of BDCP Conservation Strategy Development Process and Work Products', May 24, 2007 provided by SAIC planning team.

[iv] WRC (U.S. Water Resources Council). 1983. Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. Washington, D.C.: U.S. Government Printing Office.

[v] See http://www.lacpra.org/ for details of the Master Plan.

[vi] Reed, Denise J. 2006. Seeing the Future of the Louisiana Coast. Pages 45-47 in: G. Arnold (ed.) 'After the Storm: Restoration of America's Gulf Coast Wetlands'. Special Report of the National Wetlands Newsletter. Environmental Law Institute, Washington DC.

[vii] The main report and supporting documents can be found at http://www2.defra.gov.uk/research/project_data/More.asp?I=FD2013

[viii] http://www.defra.gov.uk/environ/fcd/policy/smpguid/vol2apph.pdf

[ix] See page 4 of Appendix B of the Louisiana Master Plan for an example (under 'Plan' at www.lacpra.org).

[x] See Table 5.2 in http://www.defra.gov.uk/science/project_data/DocumentLibrary/fd2013/fd2013_2318_OTH.pdf for a comparison of scoring systems.

[xi] See Kangas et al. (2003) for an example if using used Multicriteria Analysis to integrate cardinal and ordinal data into "acceptability indices" for forest ecosystem management.
[Kangas, J. Hokkanen, J., Kangas, A.S., Lahdelma, R., and P. Salminen. 2003. Applying Stochastic Multicriteria Acceptability Analysis to Forest Ecosystem Management with Both Cardinal and Ordinal Criteria. Forest Science 49: 928-937.]

[xii] See Zuboy et al. (1981) for an example of the application of this technique to fisheries management.
[Zuboy, J.R. 1981. A New Tool for Fisheries Managers: The Delphi Technique, North American Journal of Fisheries Management 1:55-59].

[xiii] See (Lempert et al. 2006; Lempert et al. 2003) for background on RDM and Groves et al., (2006) for a recent application to planning in coastal Louisiana.
[Groves, D., Ortiz, D., Fischbach, J., Reed, D., and Willis, H. 2006. Applying Robust Decisionmaking to the Risk-Informed Decision Framework for Louisiana Coastal Protection and Restoration. PM-2160-USACE, RAND, Santa Monica, CA.
Lempert, R. J., Groves, D. G., Popper, S. W., and Bankes, S. C. 2006. A General, Analytic Method for Generating Robust Strategies and Narrative Scenarios. Management Sciences, 52(4).
Lempert, R. J., Popper, S. W., and Bankes, S. C. 2003. Shaping the Next One Hundred Years: New methods for quantitative, long-term policy analysis, RAND, Santa Monica, CA.]

[xiv] See Table H2-2 at http://www.defra.gov.uk/environ/fcd/policy/smpguid/vol2apph.pdf for an example of this approach.

[xv] See Annex H1 in http://www.defra.gov.uk/environ/fcd/policy/smpguid/vol2apph.pdf

[xvi] Simm et al. (2002) at http://hydr.ct.tudelft.nl/wbk/public/gelder/paper101f.doc

[xvii] See Figure 3.2.7 in Appendix B under Plan at www.lacpra.org for an example

[xviii] See Figure 3 in the Alternatives Framework Report available at http://www.southbayrestoration.org/pdf_files/ADF_Final_Report_Aug2004.pdf for an example of use in South Bay planning.

Attachment A
Draft Scoring Tables for Magnitude and Certainty
from the Draft Scientific Evaluation or "Vetting" Process for the Delta Regional Ecosystem Restoration Implementation Plan (July 6, 2007 version)

Table 1 - Magnitude of Ecological Outcomes (positive or negative).

4 = High magnitude: expected sustained major population level effect, e.g., the outcome addresses a key limiting factor, or contributes substantially to the natural productivity, abundance, spatial distribution and/or diversity (both genetic and life history diversity) of a species' population, or has a landscape scale habitat effect, including habitat quality, spatial configuration and/or dynamics. Requires a large-scale Action.
3 = Medium magnitude: expected sustained minor population effect or effect on large area or multiple patches of habitat. Requires at least a medium-scale Action.
2 = Low magnitude: expected sustained effect limited to small fraction of population, addresses productivity and diversity in a minor way, or limited spatial or temporal habitat effects.
1 = Minimal or zero magnitude: Conceptual model indicates little or no effect or scale of Action is small.

Table 2 -Certainty of Ecological Outcomes (positive or negative)

4 = High certainty: Understanding is high (based on peer-reviewed studies from within system and scientific reasoning supported by most experts within system) and nature of outcome is largely unconstrained by variability (i.e., predictable) in ecosystem dynamics, other external factors, or is expected to confer benefits under conditions or times when model indicates greatest importance.
3 = Medium certainty: Understanding is high but nature of outcome is dependent on other highly variable ecosystem processes or uncertain external factors. OR Understanding is medium (based on peer-reviewed studies from outside the system and corroborated by non peer-reviewed studies within the system) and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors
2 = Low certainty: Understanding is medium and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors OR Understanding is low (based on non peer-reviewed research within system or elsewhere) and nature of outcome is largely unconstrained by variability in ecosystem dynamics or other external factors
1 = Little or no certainty: Understanding is lacking (scientific basis unknown or not widely accepted) OR Understanding is low and nature of outcome is greatly dependent on highly variable ecosystem processes or other external factors